REMARKS

Claims 1-32 are pending in the application.

Entry of the Amendment is respectfully requested along with reconsideration and review of the claims on the merits.

Response to Examiner's Comments

A. The Examiner notes that the language of claims 10 and 27 ("FeCo in a weight ratio of 70:30 and FeNiMo in a weight ratio of 75:20:5") have been taken to mean a 70 wt% Fe, 30 wt% Co alloy and a 75 wt% Fe, 20 wt% Ni and 5 wt% Mo alloy.

In response, Claims 10 and 27 are amended to correct an inadvertent error. The phrase "a weight ratio" is changed to "an atomic ratio". Applicants submit that it is generally practiced in the art that compositions of magnetic substances are expressed in atomic percentages, as described, for example, in the cited reference of Oda et al. (U.S. Patent No. 5,435,903).

The original specification did not list weight ratio or atomic ratio (see page 8, [0037]). The amendment dated July 8, 2004, inadvertently added "weight ratio". Applicants' invention was intended to recite "an atomic ratio", which is the commonly used standard for composition of magnetic substances.

B. The Examiner notes that claim 15 appears to have a typographical error and should depend from claim 13, not claim 11 (since claim 11 does not recite a lubricant layer).

In response to the Examiner's note regarding claim 15, Applicants change the dependency from claim 11 to claim 13, as suggested by the Examiner. Applicants also amend claim 15 to recite "a lubricant formed in a layer having a thickness of 1-10 nm."

Entry of the amendment is respectfully requested.

Response to Examiner's Claim Rejections - 35 U.S.C. §102 and §103

A. Claims 1, 2, 8, 19-21, 23 and 26 are rejected under 35 U.S.C. §102(b) as assertedly being anticipated by Sawazaki (U.S. Patent No. 4,422,106) as evidenced by Oda et al. (U.S. Patent No. 5,435,903) for the reasons of record as set forth in Paragraph No.'s 5-16 of the Office Action mailed on October 19, 2004.

Regarding the relative permeability element of Claim 1, although the Examiner recognizes that Sawazaki does not expressly teach the required relative permeability, the Examiner takes the position that this limitation is necessarily met by the reference. The Examiner notes that relative permeability can be measured via application of a DC magnetic field or through the application of an AC magnetic field. However, the Examiner maintains that Applicants have not defined in the specification or the claims how the relative permeability is measured.

The Examiner points to Oda for teaching that the relative permeability of a magnetic material when measured by an applied AC magnetic field is dependent on the frequency at which it is measured, with relative permeability decreasing as frequency increases (see figure 4 of Oda). The Examiner recognizes that DC relative permeability is not frequency dependent. Giving the claims their broadest reasonable interpretation, the Examiner interprets "relative permeability" in the instant claims, to mean relative permeability as measured by an AC magnetic field. The Examiner takes the position that any magnetic material is within the scope of Applicants'

claimed relative permeability at some frequency. Thus, the Examiner asserts that the relative permeability limitation is met.

The Examiner disagrees with Applicants' previous arguments that one of ordinary skill would understand that relative magnetic permeability, in the context of the present invention, is measured by applying a DC magnetic field, and further disagrees that "claim 1 directed to a transfer method clearly recites the step of applying a DC magnetic field" (page 12 of response).

First, the Examiner notes that limitations contained in the specification can not be read into the claims for the purpose of avoiding prior art. The Examiner asserts that the present claims do not recite how the magnetic permeability is measured and are hence open to both DC and AC, regardless of what one of ordinary skill in the art might understand. Second, the Examiner notes that there is no evidence in the as-filed disclosure to support Applicants' allegation that one of ordinary skill would understand that the relative magnetic permeability, in the context of the present invention, is measured by applying a DC magnetic field. The Examiner asserts that there is no disclosure as to how Applicants have measured the relative magnetic permeability, and hence, one would postulate that any measurement technique could be utilized.

Furthermore, the Examiner asserts that Applicants' specification clearly teaches that during information transfer, application of both AC or DC magnetic fields are known in the art (Paragraph 0010).

In addition, the Examiner disagrees that the measurement of relative magnetic permeability is ordinarily carried out by applying a DC magnetic field (page 13 of response). In

this regard, the Examiner acknowledges that relative magnetic permeability can be measured in a DC magnetic field, as shown by the recited references. However, what is used in the other references is said to not be relevant to what Applicants have disclosed. Because Applicants have neither claimed measurement in a DC magnetic field, nor disclosed such measurement technique in their as-filed disclosure, the Examiner finds no support to limit the claim language accordingly.

B. Claims 1-9, 18-26 and 32 are rejected under 35 U.S.C. §102(b) as assertedly being anticipated by Ishida et al. (W098/03972) as evidenced by Oda et al. ('903) for the reasons of record as set forth in Paragraph No.'s 17-36 of the Office Action mailed on October 19, 2004.

C. Claims 1-9, 18-26 and 32 are rejected under 35 U.S.C. §103(a) as assertedly being unpatentable over Ishida et al. (WO '972) in view of Oda et al. ('903) and Sawazaki ('106) for the reasons of record as set forth in Paragraph No.'s 38-41 of the Office Action mailed on October 19, 2004.

D. Claims 10 and 27 are rejected under 35 U.S.C. §103(a) as assertedly being unpatentable over Ishida et al. as applied above, and further in view of Takahashi et al. (U.S. Patent No. 5,173,370) for the reasons of record as set forth in Paragraph No.'s 42-47 of the Office Action mailed on October 19, 2004.

E. Claims 10 and 27 are rejected under 35 U.S.C. §103(a) as assertedly being unpatentable over Ishida et al. in view of Oda et al. and Sawazaki as applied above, and further in view of Takahashi et al. ('370) for the reasons of record as set forth in Paragraph No.'s 48-49 of the Office Action mailed on October 19, 2004.

F. Claims 16, 17 and 31 are rejected under 35 U.S.C. §103(a) as assertedly being unpatentable over Ishida et al. as applied above, and further in view of Nishimatsu et al. (U.S. Patent No. 4,701,375) for the reasons of record as set forth in Paragraph No.'s 50-53 of the Office Action mailed on October 19, 2004.

G. Claims 16, 17 and 31 are rejected under 35 U.S.C. §103(a) as assertedly being unpatentable over Ishida et al. in view of Oda et al. and Sawazaki as applied above, and further in view of Nishimatsu et al. ('375) for the reasons of record as set forth in Paragraph No.'s 54-55 of the Office Action mailed on October 19, 2004.

H. Claims 11-15 and 28-30 are rejected under 35 U.S.C. §103(a) as assertedly being unpatentable over Ishida et al. as applied above, and further in view of Kitaori et al. (U.S. Patent No. 5,796,533) and Dearnaley et al. (U.S. Patent No. 5,922,415) for the reasons of record as set forth in Paragraph No.'s 56-67 of the Office Action mailed on October 19, 2004.

I. Claims 11-15 and 28-30 are rejected under 35 U.S.C. §103(a) as assertedly being unpatentable over Ishida et al. in view of Oda et al. and Sawazaki as applied above, and further in view of Kitaori et al. ('533) and Dearnaley et al. ('415) for the reasons of record as set forth in Paragraph No.'s 68-69 of the Office Action mailed on October 19, 2004.

Applicants respectfully traverse each of the rejections.

The referenced documents to Sawazaki and Ishida do not anticipate each and every element of Applicants' claimed invention. Namely, the cited references do not disclose a transfer method where the relative magnetic permeability of the magnetic layer of the master carrier for magnetic transfer is within the range of 10-1,000 as claimed. Likewise, the referenced

documents when combined with Oda or any of the other secondary references do not render obvious the present invention.

One of ordinary skill in reading the present specification would understand that relative magnetic permeability, in the context of the present invention, is measured by applying a DC magnetic field. One of ordinary skill would understand that relative magnetic permeability, in the context of the present invention, and this field of art in general, is measured by applying a DC magnetic field.

In the present invention, relative magnetic permeability is in the range of 10 to 1,000. Applicants found that poor transfer resulted when relative magnetic permeability of the magnetic layer of the master carrier was high (see specification, paragraphs [18] to [22]). When relative permeability is too low, the magnetic field for transfer is not absorbed in the master carrier. There is nothing in the prior art which teaches this characteristic feature of the present claims.

In the present invention, transfer is performed by applying a DC magnetic field, and the characteristics in a DC magnetic field exert influence.

Therefore, it would have been obvious to those skilled in the art that what is referred in the present invention is relative magnetic permeability measured in a DC magnetic field.

One of ordinary skill would understand that a frequency independent approach by applying a DC magnetic field was used, particularly in the examples at pages 11-13 and Tables 1-3 of the specification. At the top of page 12, for example, Applicants disclose that "master carriers for magnetic transfer A-G having different relative permeability values were prepared."

This statement would make no sense if a frequency dependent approach using an AC magnetic field were applied.

Thus, relative magnetic permeability measured in an AC magnetic field is not related to the present invention.

Furthermore, relative magnetic permeability changes in AC depending on the frequency. In the present invention, however, only the transfer by direct current is in question. See claim 1: "applying a DC magnetic field whereby information is transferred." There is no description on such frequency in the present invention, and this also supports the fact that the present invention is related to relative magnetic permeability in DC.

For further support of the value of relative magnetic permeability in DC, the following article on magnetic transfer is submitted as a reference material: R. Sugita, T. Kinoshita, O. Saito, T. Murano, M. Nishikawa, M. Nagao: "A Novel Magnetic Contact Duplication Technique for Servo-Writing on Magnetic Disks", IEEE Trans. Hag. Vol. 36, No.5, pp. 2285-2287, 2000. In this article, the value of relative magnetic permeability is discussed, but there is no specific description on the method to measure relative magnetic permeability. However, magnetic transfer is performed by applying a DC magnetic field, and those skilled in the art would understand that it is relative magnetic permeability in DC.

Applicants also point out that claim terms are construed in light of the specification and as understood by one of ordinary skill in the art. This is different from importing limitations from the specification into the claims as suggested by the Examiner.

Because it is well know that relative permeability when measured by AC magnetic field is dependent on the measurement frequency, and because the specification does not identify such frequency, then one of ordinary skill would immediately recognize that relative permeability in the context of the present invention is measured in an applied DC magnetic field.

Thus, the cited references fail to disclose or render obvious a transfer method where the relative magnetic permeability of the magnetic layer of the master carrier for magnetic transfer is within the range of 10-1,000 as claimed.

Accordingly, Applicants respectfully request reconsideration and withdrawal of the Examiner's rejections under 35 U.S.C. §102(b) and §103(a).

Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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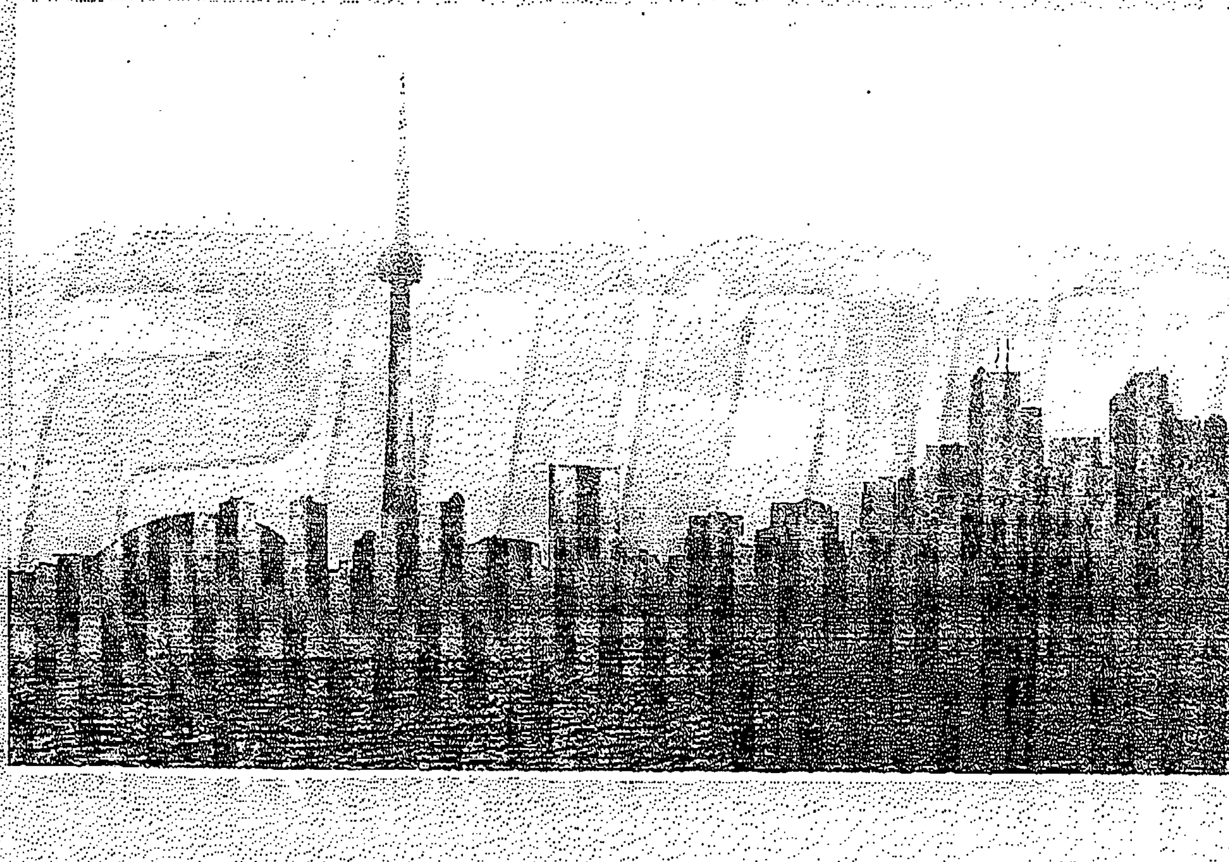
PART I OF TWO PARTS



SELECTED PAPERS FROM THE 2000 INTERNATIONAL MAGNETICS CONFERENCE (INTERMAG 2000)
Royal York Hotel, Toronto, Ontario, Canada, April 9–12, 2000

See p. 2109, Part I, for Intermag 2000 Table of Contents. Intermag 2000 papers begin on p. 2137, Part I. See Part II, p. 3475, for Regular papers.

IEEE TRANSACTIONS ON MAGNETICS, VOL. 36, NO. 5, SEPTEMBER 2000

A Novel Magnetic Contact Duplication Technique for Servo-Writing on Magnetic Disks

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Abstract—A novel magnetic contact duplication technique is proposed in order to write a servo signal on hard disks and floppy disks at a high speed and a low cost. In this technique a magnetic layer of a master disk is lithographically patterned in accordance with a servo signal, having low coercivity, and dc magnetic field is applied to a slave disk contacted with the master one. A computer simulation using finite element method shows that the pattern of the master disk can be duplicated on a slave one. The possibility of duplication by using this technique is confirmed from experimental results in which a Bitter pattern of a duplicated slave medium is clearly observed.

Index Terms—Magnetic contact duplication, servo-writing, hard disk, floppy disk.

I. Introduction

SINCE hard disks and floppy disks have become high density and large capacity, it is a serious problem to write a servo signal at a high speed and a low cost. The magnetic contact duplication technique seems to be one of the candidates to solve the problem. In the conventional duplication technique, a master medium has a magnetic layer with a flat surface and high coercivity in which a signal is recorded as a change of magnetization, and ac magnetic field is applied to a slave medium contacted with the master one. The change of magnetization of the master medium is duplicated on the slave one. The magnetic layer of the master medium must have coercivity H_c more than about 5000 Oe in the conventional duplication technique, because H_c of hard and floppy disks has been heightening along with the increase in recording density [1]–[3]. It is very difficult not only to make such a master disk but also to write a servo signal on it.

The purpose of this paper is to propose a novel magnetic contact duplication technique which solves the above mentioned problems.

II. Magnetic Contact Duplication with Lithographically Patterned Master Disk

In a novel magnetic contact duplication technique proposed here, the magnetic layer of a master disk is lithographically

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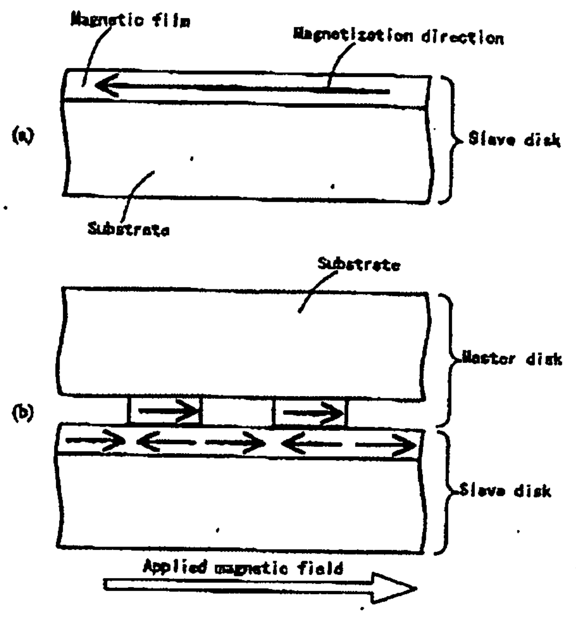

Fig. 1. Schematic of the process used for duplication. (a) Initial magnetization of a slave disk. (b) Application of magnetic field for duplication.

patterned in accordance with a servo signal and has low H_c less than a few hundreds Oe, and dc magnetic field is applied to a slave disk contacted with the master one.

A procedure of the duplication using this technique is as follows. In the first place, the magnetic layer of the slave disk is initially magnetized in one direction as shown in Fig. 1(a). In the next place, the slave disk is contacted with the master one, and dc magnetic field in the direction opposite to that of the initial magnetization is applied to the disks as shown in Fig. 1(b). When the strength of the magnetic field is appropriate, magnetization of the slave disk remains almost unchanged in the parts where the disk is contacted with the magnetic layer of the master disk, while magnetization is reversed in the parts where the slave disk is not contacted with it as shown in Fig. 1(b). As a result, the lithographically fabricated pattern of the master disk is duplicated on the slave disk as the change of magnetization direction.

This novel duplication technique has the merits that high H_c is not required for the master disk and applied magnetic field is dc one. Although the pattern of sub-micron scale must be lithographically formed on the master disk, it is not a serious problem because precision processing technology for semiconductor and optical disk can be used.

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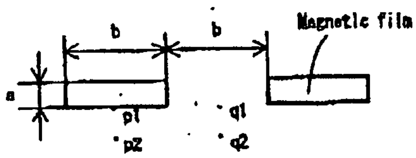

Fig. 2. Magnetic film configuration of the master disk simulated with two-dimensional finite element method.

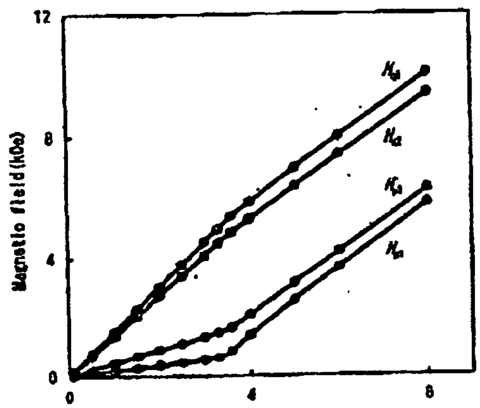

Fig. 3. Applied magnetic field dependence of magnetic field near the magnetic layer of the master disk.

III. Simulation

We used two-dimensional finite element method to simulate the magnetic field distribution near the magnetic layer of the master disk when a magnetic field is applied to it. It was assumed that the track width of the servo signal is infinite and that the magnetic layer consists of discrete magnetic films. As shown in Fig. 2, the simulation was carried out under the condition that magnetic films of thickness a, length b and width ∞ run parallel with the wide axis at intervals of b, and the magnetic field is applied in the length direction. Hysteresis of the magnetic films was neglected.

Fig. 3 shows the applied magnetic field H_a dependence of the magnetic field near the magnetic layer. The thickness, length, interval, the saturation magnetization M_s and the permeability μ of the magnetic layer are 0.1 μm, 0.5 μm, 0.5 μm, 1900 emu/cm^3 and 100, respectively. H_{p1}, H_{p2}, H_{q1} and H_{q2} are the magnetic field at the points p1, p2, q1 and q2 shown in Fig. 2, respectively. The point p1 corresponds to an element on the magnetic film, q1 corresponding to one between the magnetic films. The point p2 corresponds to an element 0.1 μm apart from the magnetic film surface, q2 corresponding to one between the magnetic films. From Fig. 3 it is found that there is the range of H_a where H_{q1} and H_{q2} are larger than H_c of hard or floppy disks while H_{p1} and H_{p2} are less than that. For example, if a slave disk with H_c of 2000 Oe contacted with the master disk is in the applied magnetic field of 2500 Oe, magnetization of the slave disk remains unchanged in the parts where the disk is contacted with the magnetic films of the master disk, while magnetization is reversed in the parts where the slave disk is not contacted with those films, because H_{q1} and H_{q2} are over 3000 Oe while H_{p1} and H_{p2} are less than

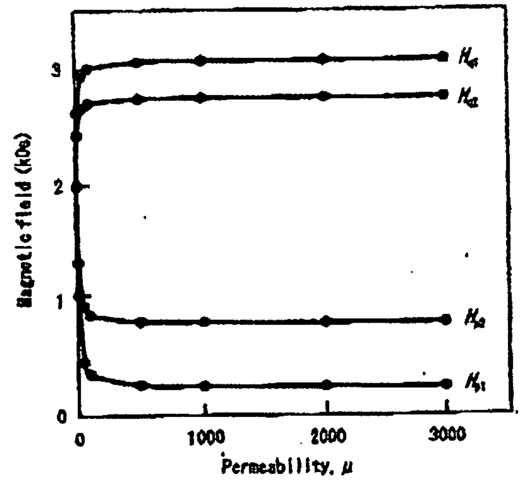

Fig. 4. Dependence of magnetic field on permeability of the magnetic layer.

about 1000 Oe. The pattern of the master disk can be therefor duplicated on the slave one.

Fig. 4 shows the dependence of the magnetic field at th points p1, p2, q1 and q2 in Fig. 2 on μ of the magnetic layer. Th configuration is the same as that in Fig. 2. Thickness a, lengt b, M_s, H_a are 0.1 μm, 0.5 μm, 1900 emu/cm^3 and 2000 O respectively. It is seen from Fig. 4 that high μ is not necessar μ of about 100 being enough.

IV. Experimental Results

Photomicrographs shown in Fig. 5 are Bitter patterns of slave medium duplicated by using a lithographically pattern master one. The master one used here had a patterned $Fe_{80}Co$ film with H_c of 70 Oe, the thickness of 0.2 μm and the leng of 4 μm at intervals of 4 μm on a Si substrate. The slave o had a metal particulate magnetic layer with H_c of 1600 Oe a the thickness of 0.3 μm. The procedure of the experiment w as follows. After the slave medium was initially magnetized one direction with magnetic field of 6 kOe, dc magnetic fi H_a for duplication in the reverse direction was applied to t slave medium contacted with the master one. The slave medi duplicated with various H_a was developed by using the Bit method. Fig. 5(a)–(c) are Bitter patterns for the samples dup cated with H_a of 0.6 k, 1.9 k and 3.0 kOe, respectively. Fig shows that the pattern of the master medium was most clea duplicated on the slave one at H_a of 1.9 kOe.

Fig. 6 shows the relationship between quantity of magne powder on magnetization transition of the slave samples H_a. The quantity of the powder is shown as the width of powder on the transition. As is evident from Fig. 6, duplicat was performed best when H_a was around 2 kOe. This agr well with the abovementioned simulation result qualitativ But it is the subject for a future study to compare the exp mental results with the simulation quantitatively.

Fig. 7 is a Bitter pattern of the slave medium recor with a magnetic head which has Metal-In-Gap structure 1200 emu/cm^3 in M_s and 0.3 μm in gap length. The record current was a square wave of 8 μm in wavelength and se

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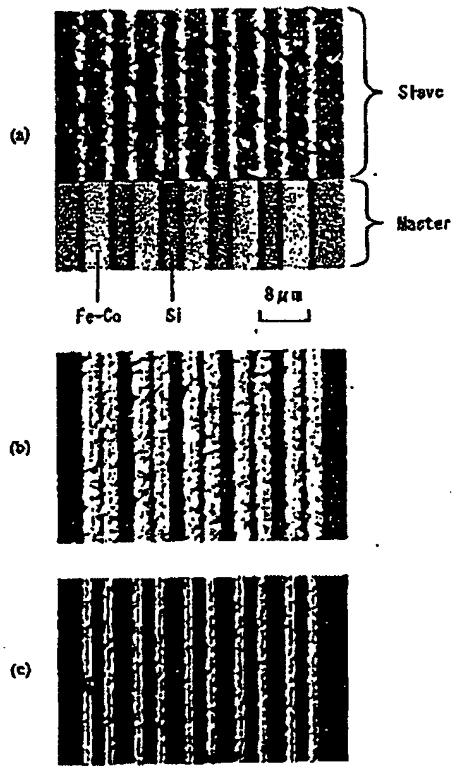

Fig. 5. Bitter patterns of the slave medium duplicated with H_a of 0.6 kOe (a), 1.9 kOe (b) and 3 kOe (c).

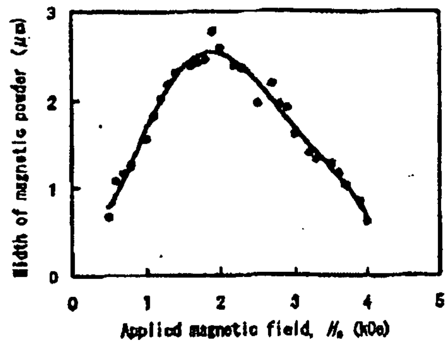

Fig. 6. Relation between width of magnetic powder m and applied magnetic field.

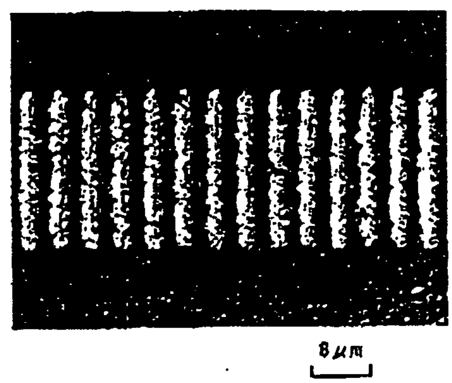

Fig. 7. A bitter pattern of the slave medium recorded with a magnetic head.

optimum value. It is found from Fig. 5(b) and Fig. 7 that the quantity of Bitter powder on the transition of the duplicated slave sample is almost the same as that of the slave sample recorded with a magnetic head.

From the experimental results above, the feasibility of real- . the novel duplication technique is proved, and it becomes that quality of reproduced signal from duplicated disks is ..ted to be as good as that from disks recorded with magnetic heads.

V. Conclusion

It has been confirmed that the magnetic contact duplication is possible on slave disks with high H_c by using lithographically patterned master disks, even if H_c of master ones is low. This novel duplication technique makes it possible to write servo signal on hard and floppy disks in a high speed and a low cost.

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